Essential Geodetic Variables

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Essential Variables

- Global Climate Observing System (GCOS)
  - Developed concept of Essential Climate Variables in 1990s
    - To provide guidance for observing critical climate variables in face of declining core observational networks
  - Essential Climate Variables (EGVs)
    - Variable (physical, chemical, biological) critical to characterizing Earth's climate
    - Provide empirical evidence needed to understand and predict evolution of climate, guide mitigation and adaptation measures, assess risks and enable attribution of climatic events to underlying causes, and underpin climate services
    - Identified based on relevance, feasibility, and cost effectiveness
    - Broadly adopted in science and policy circles as basis for prioritized requirements setting and focused, coordinated action
- Global Ocean Observing System (GOOS)
  - Identified Essential Ocean Variables

The Global Ocean Observing System

Essential Ocean Variables

[Click on each EOV for their repsective spec sheets]

PHYSICS	BIOGEOCHEMISTRY	BIOLOGY AND ECOSYSTEMS
Sea state	Oxygen	Phytoplankton biomass and diversity
Ocean surface stress	Nutrients	Zooplankton biomass and diversity
Sea ice	Inorganic carbon	Fish abundance and distribution
Sea surface height	Transient tracers	Marine turtles, birds, mammals abundance and distribution
Sea surface temperature	Particulate matter	Hard coral cover and composition
Subsurface temperature	Nitrous oxide	Seagrass cover
Surface currents	Stable carbon isotopes	Macroalgal canopy cover
Subsurface currents	Dissolved organic carbon	Mangrove cover
Sea surface salinity	Ocean colour *(Spec Sheet under development)*	Microbe biomass and diversity (*emerging)
Subsurface salinity		Benthic invertebrate abundance and distribution (*emerging)
Ocean surface heat flux		

http://www.goosocean.org/index.php?option=com_content&view=article&id=14&Itemid=114

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EOV: Sea Surface Height

Variable Information	
Name of Variable (ECV and/or EOV)	Sea Surface Height
Sub-Variables[1]	Sea level anomaly, sea surface height gradients, sea level extremes, tidal range
Derived Variables or Products [2]	Upper ocean heat content, tropical cyclone heat potential, ocean volume variability, sea level rise trends, surface geostrophic currents, data assimilative operational mesoscale ocean forecasts (e.g. Mercator-Ocean; HYCOM; ENSO)
Supporting Variables [3]	Geoid, mean sea surface, geodetic datum, gravity measurements, tidal harmonics, subsurface temperature and salinity, air pressure, sea state, land position, wind stress
Contact/Lead Expert(s) [4]	GLOSS Group of Experts for sea level stations; NASA/CNES Ocean Surface Topography Science Team and Sea Level Change Science Team chairs Coastal Altimetry Worksop chairs; EUMETSAT operational altimetry; Geoid and geodesy expert groups (DTU and NGDC)

EOV: Sea Surface Height

Observation Deployment & Maintenance				
Observing Elements[8]	Satellite Altimetry (OSTST)	Tide gauges (GLOSS)	Moorings (OceanSITES, DBCP)	Tsunami Moorings (DART Network)
Relevant measured parameter(s)	SSH	Relative sea level and SSH	SSH variability	SSH Variability
Sensors /Technique	Pulse limited radar (T/P and Jason heritage); Delayed Doppler SAR-mode radar (CryoSat heritage)	Tide gauges	Bottom pressure/ inverted echo sounder	Bottom Pressure
Phenomena addressed	Circulation Sea Level Fronts and Eddies	Sea Level Extreme Events	Sea Level Circulation Extreme Events	Sea Level Extreme Events
Readiness Level [1]	Mature level 8 (sustained observations require better interagency collaboration)	Mature level 8	Mature level 7	Mature 8
Spatial sampling	1-D along-track ~30 km; 2-D ~100 km with multiple altimeters	Point samples	Point samples; networks at tens of km spacing	Specific locations
Temporal sampling	A few days with multiple altimeters	Better than 1 Hz to several samples per hour	Better than 1 Hz to several samples per hour	<hourly
Special Characteristics/ Contributions	Global coverage; greater precision with reprocessing; greater accuracy along repeat orbit ground-tracks; less accuracy with where geoid less certain near coast, shelf-edge, and in ice-covered regions	High precision and accuracy	High precision	Real time data delivery, continuous observations
Random Uncertainty estimate (units, one standard dev).	2 cm for 1 Hz (7-km) along-track sample; 5 mm for 10-day average analysis; 0.4 mm for yearly averages	1-5 cm for hourly average		
Uncertainty in the bias Units, one standard deviation)	Unknowable?	?		

OOPC_SSH_Specification_v5.2.pdf

EOV: Sea Surface Height

Future observing Elements		
Observing Elements	Satellite Swath altimetry	
Relevant measured parameter(s)	SSH; gradient(SSH)	
Sensors	cross-track interferometer based	
Phenomena addressed	Circulation Sea Level Fronts and Eddies Coastal Shelf Processes	
Readiness Level [1]	Pilot/Concept 3-4. Commitment to mission but won't fly until 2020. Active development of potential applications, and error budget; AirSWOT prototype	
Spatial sampling	1 km x 1 km; 120-km wide swath	
Temporal sampling	22 day repeat at nadir; 3-day repeat sub-cycle some tracks; 3 to 7 day revisit within swath view depending on latitude	
Special Characteristics or Contribution	Very high spatial resolution; 2-D swath gives vector SSH gradient	
Estimated time when part of the observing system	2020	
Random Uncertainty estimate (units, 1 standard deviation).	Order 1 cm	
Uncertainty in the bias Units, one standard deviation)		

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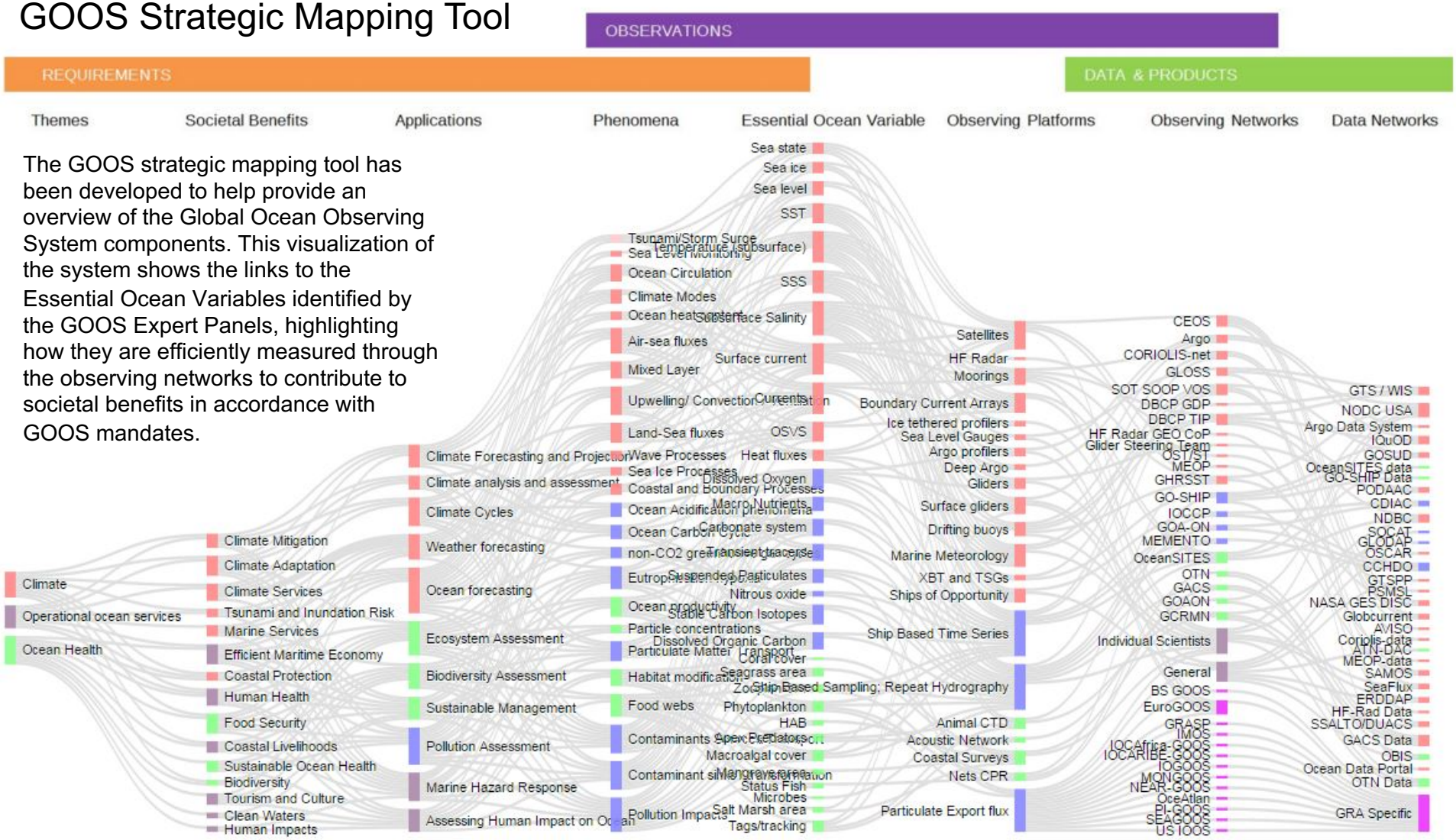
The Global Ocean Observing System

GOOS Strategic Mapping Tool



The GOOS strategic mapping tool has been developed to help provide an overview of the Global Ocean Observing System components. This visualization of the system shows the links to the Essential Ocean Variables identified by the GOOS Expert Panels, highlighting how they are efficiently measured through the observing networks to contribute to societal benefits in accordance with GOOS mandates.

http://www.goosocean.org/index.php?option=com_content&view=article&id=120&Itemid=277

Essential Geodetic Variables

- Observed variables
  - Crucial to characterizing geodetic properties of Earth
  - Key to sustainable geodetic observations
    - Positions of reference objects (ground stations, radio sources), EOPs
    - Gravity measurements (ground-based, space-based)
- Assign requirements to each EGV
  - Accuracy, spatial and temporal resolution, latency, stability, …
- Derive requirements
  - On EGV-dependent products (TRF, CRF, …)
  - On infrastructure (observing systems)
- Can be used to update GGOS2020 book
  - Bottoms-up approach to deriving requirements
    - Complements top-down approach used in GGOS2020 book (user needs)
- Establish Committee within GGOS BPS
  - To create list of EGVs, assign requirements to them, etc.
  - Committee will include representatives of
    - IAG Services, Commissions, Intercommission Committees, GGOS Focus Areas

Committee on EGVs

GGOS
- Detlef Angermann (Germany)
- Richard Gross, Chair (USA)
- Harald Schuh (Germany)

GGOS Focus Area 1
(Unified Height System)
- Bernhard Heck (Germany)

GGOS Focus Area 2
(Geohazards Monitoring)
- Diego Melgar (USA)

GGOS Focus Area 3
(Sea Level Change)
- Don Chambers (USA)

GGOS Focus Area 4
(Space Weather)
- Ehsan Forootan (UK)

IAG Commission 1
- Markus Rothacher (Switzerland)
- Geoffrey Blewitt (USA)

IAG Commission 2
- Kosuke Heki (Japan)
- Thomas Gruber (Germany)

IAG Commission 3
- Jianli Chen (USA)
- Jose Ferrandiz (Spain)

IAG Commission 4
- Jens Wickert (Germany)
- Pawel Wielgosz (Poland)

IAG ICC Theory
- Yoshiyuki Tanaka (Japan)
- Mattia Crespi (Italy)

IERS
- Tom Herring (USA)

IGS
- Tom Herring (USA)
- Michael Moore (Australia)

ILRS
- Erricos Pavlis (USA)
- Jürgen Müller (Germany)

IVS
- John Gipson (USA)
- Johannes Böhm (Austria)

IDS
- Laurent Soudarin (France)
- Jean-Michel Lemoine (France)

IGFS
- Urs Marti (Switzerland)
- Georgios Vergos (Greece)

BGI
- Sylvain Bonvalot (France)

ICGEM
- E. Sinem Ince (Germany)

ISG
- Jianliang Huang (Canada)

IGETS
- Hartmut Wziontek (Germany)
- Jean-Paul Boy (France)

IDEMS
- Christian Hirt (Germany)
- Michael Kuhn (Australia)

PSMSL
- Svetlana Jevrejeva (UK)

BIPM
- TBD

Total: 35

Essential Polar Motion Variables

Variable Information

- Name of variable
  - Polar motion (PMX, PMY)
- Sub-variables
  - Polar motion rate (PMX-rate, PMY-rate)
- Derived variables or products
  - Excitation functions (chi-x, chi-y)
- Contact/lead expert(s)
  - IERS

Current Observing Elements

Responsible Service	IVS	ILRS	ILRS	IGS	IDS
Relevant Parameters	Polar motion	Polar motion	Variation of latitude	Polar motion	Polar motion
Sensors/Technique	VLBI	SLR	LLR	GNSS	DORIS
Readiness Level	Maturity level 8	Maturity level 8	Maturity level 8	Maturity level 8	Maturity level 7
Temporal resolution	1-day	1-day		1-day (UR, R, F)	1-day
Latency				3-9 hours (UR) 17-41 hours (R) 11-17 days (F)	
Uncertainty (Current Capability)				50 μas (UR) 40 μas (R) 30 μas (F)	
Uncertainty (Future Requirement)					

Future Observing Elements

Observing Element	GNSS	Ring Laser Gyroscope	Superfluid Helium Gyroscope
Relevant Parameters	Polar motion	Rotation vector	
Sensors/Technique			
Readiness Level	Maturity level 6	Maturity level 4	Maturity level 2
Temporal Resoluiton			
Latency	Near real time		
Uncertainty (Current Capability)			


شكراً جزيلاً
thank you
danke
謝謝
ngiyabonga
рахмат
teşekkür ederim
gracias
merci
obrigado
спасибо
Баярлалаа
bedankt
dziękuję
go raibh maith agat
mochchakkeram
sukriya
kop khun krap
terima kasih
감사합니다
ありがとう
arigatô
dakujem
grazie
takk
tapadh leat
мерси
ευχαριστώ
sagolun
mersi
barka
welalin
tack
spas
kia ora
dank je
vinaka
спасибі
blagodaram
misaotra
matondo
paldies
grazzi
mahalo
faafetai lava
kiitos
dankie
nanni
nandri
dhanyavad
maururu
hvala
köszönöm
gracje
bayarlalaa
enkosi
akun
dankon
aciu
хвала
asante
manana
obrigada
tenki
murakoze
djiere dieuf
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chokrane
chnorakaloutioun
gratias ago
gràcies
sulpáy
taiku
sobodi
dėkuji
mèsi
didi madloba
najis tuke
kam sah hamnida
rahmat
tanemirt
rahmet
diolch
dhanyavadagalu
shukriya
mercê
trugarez
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